EXPERIMENT #6 - PHYSICS 230

Launching Tube

OBJECT: To study the conservation of energy by using a launching tube.

EQUIPMENT: Launching tube and accessories
Carbon paper, meter stick, clamps

THEORY: Refer to chapters 7, 8, and 12 of Resnick and Halliday.

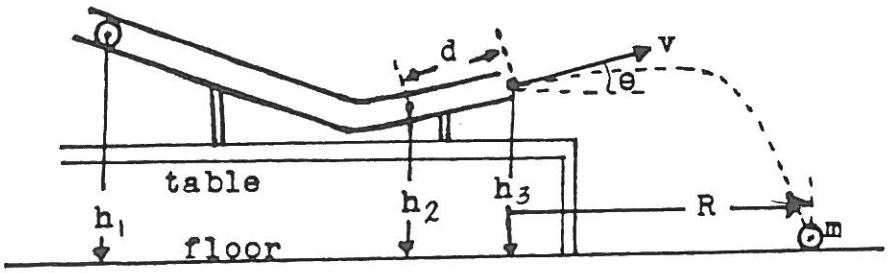
GENERAL DIRECTIONS:

A. Launching Tube:

1. Examine the launching tube and determine its principle of operation. Be sure the inside of the tube is clean and that the tube is securely anchored to the laboratory table.

2. By adjusting the angle of the tube one can obtain the condition where the steel ball just reaches the exit point of the tube with zero velocity. By using a plum line, meter stick, and a suitable horizontal reference line measure and record the initial height h_{1f} and the final height h_{3f} of the steel ball for the condition stated above. Measure the mass of the steel ball. With this information calculate the approximate energy loss E_f due to friction in the tube.

3. Adjust the angle of the tube so that the ball will leave the tube with a reasonable velocity and finally descend to the floor. A piece of ordinary paper and carbon paper taped to the floor will help to determine where the ball hits the floor. The values h_1, h_2, h_3, d, R, and r as shown in the following diagram should be measured:



r = radius of steel ball (measured with calipers)

v = exit speed of ball

This experiment should be done several times for the same tube position and the best or average value of R used for the calculations.

4. Using the conservation of energy and the values h_1, h_3, m, r, and E_f, find the speed of the ball at the exit point of the tube. The change in the ball's total kinetic energy involves the kinetic energy of translation and of rotation. The rotational energy is given by the following expression:

$$E_R = \tfrac{1}{2} I\omega^2 = \tfrac{1}{2}\left(\tfrac{2}{5} mr^2\right)\left(\tfrac{v}{r}\right)^2 = \tfrac{1}{5} mv^2$$

where I = moment of inertia, and ω = angular speed of ball

5. Using the values for d, h_2, and h_3 the elevation angle θ may be found. Using the values for θ, v, h_3, and r calculate the range R.

6. Compare this calculated value of the range R to the experimentally measured value of the range. Find the per cent error and explain why there may be an error.